

LA-UR-21-24338

Approved for public release; distribution is unlimited.

Title: Nuclear Weapons Testing Today

Author(s): Scarlett, Harry Alan

Intended for: Nuclear Fundamentals Orientation (NFO)

Issued: 2021-05-05

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.



Nuclear Fundamentals Orientation

Module 2

Nuclear Weapons Testing Today



Managed by Triad National Security, LLC for the U.S. Department of Energy's NNSA

Nuclear Weapons Testing Today



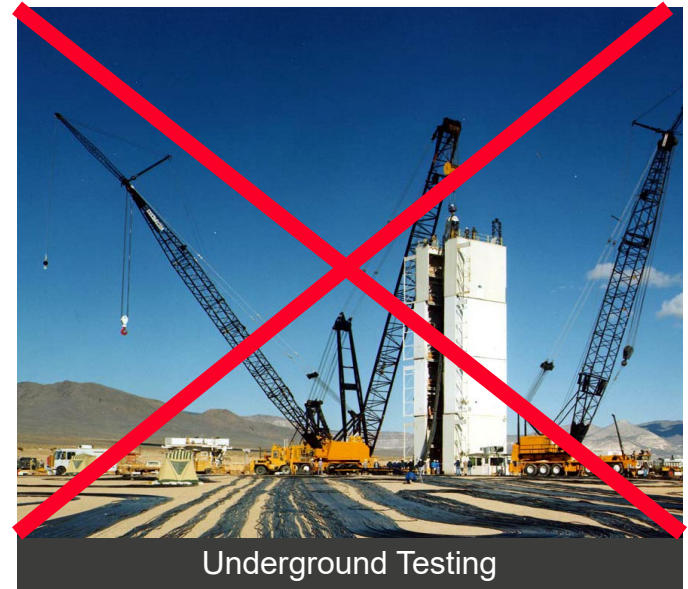
Presentation Overview:

- United States (U.S.) Nuclear Testing Evolved at End of Cold War
- Purpose of Nuclear Weapons Testing
- Four Cornerstone Tests are used at LANL Today
 - Small Scale Physics Experiments
 - Subcritical Experiments
 - Environmental/Engineering Tests
 - Hydro Tests
- Firing Sites
- Firing Sites Support Various Testing
- Firing Sites at LANL and NNSS
- Hydro Shot Videos
- Conclusions

United States (U.S.) Nuclear Testing Evolved at End of Cold War

- Proliferation of Nuclear Weapons (NW) development and the environmental concerns of NW testing moved the U.S. to evolve its testing methods
- In 1963, a “Limited Nuclear Test Ban Treaty” was signed (U.S. & USSR) based on the realization nuclear testing was an increasing source of radioactive contamination to the atmosphere, oceans, and outer space
- On August 11, 1995 upon announcing his decision to seek a Comprehensive Test Ban Treaty (CTBT), former President Clinton stated:

“I consider the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States.”



Nuclear Weapons Testing evolved, but was still deemed necessary!

Purpose of NW Testing

NW Testing is Important!

- Previous atmospheric & underground NW tests proved our weapons would work as designed until 1992
- In 1993, highly controlled, specialized, NW testing via the Stockpile Stewardship Program (SSP) was established. The SSP assures our weapons remain viable in the absence of continuing underground weapon testing:
 - Certifies safety of the weapons
 - Reaffirms reliability they will work as designed
 - Maintains nuclear weapons design and assessment capabilities
 - Demonstrates to the world our NWs' capability
 - Supports the U.S. military & political deterrent strategy toward any state adversary



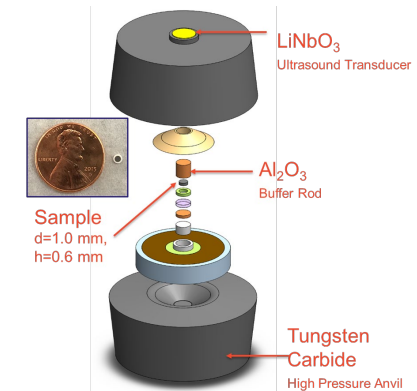
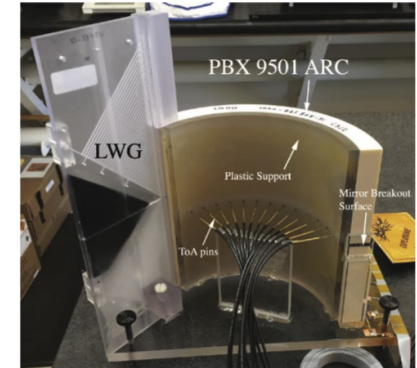
Four Cornerstone Tests are used at LANL Today

- Small Scale Physics Experiments
- Subcritical Experiments
- Environmental/Engineering Tests
- Hydrodynamic Tests

What are Small Scale Physics Experiments?

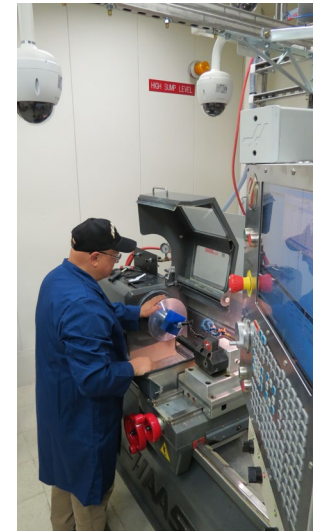
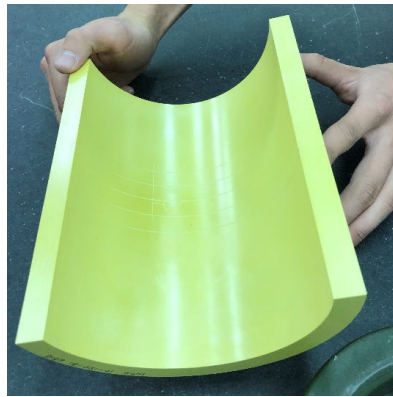
- Small Scale Physics Experiments (SSPEs) are focused on the nuclear materials and the related component testing, e.g., High Explosives (HE)
- Tests measure fundamental properties of materials at extreme conditions
- Fundamental detonation physics research
- Small scale experiments serve to generate detonation performance models

The above are just a few types of SSPEs that are performed to meet the NW needs of today



Why Do Small Scale Physics Experiments?

- The goal of SSPEs is to understand the fundamental physics and all aspects of nuclear materials and specific component performance in a NW
- Testing components and utilizing modern equipment to fabricate precise HE and inert components enables the best material and manufacturing techniques to be used in building a NW



One Example out of Many Types of SSPEs – High Explosives Pulsed Power (SSPE) Testing at Los Alamos

- High Explosives Pulsed Power (HEPP) was first used at LANL by Max Fowler in the 1950s
- LANL is part of a tri-lab collaboration with SNL and LLNL
- LANL is home to the only firing site in the U.S. configured for HEPP experiments so all U.S. work is performed here

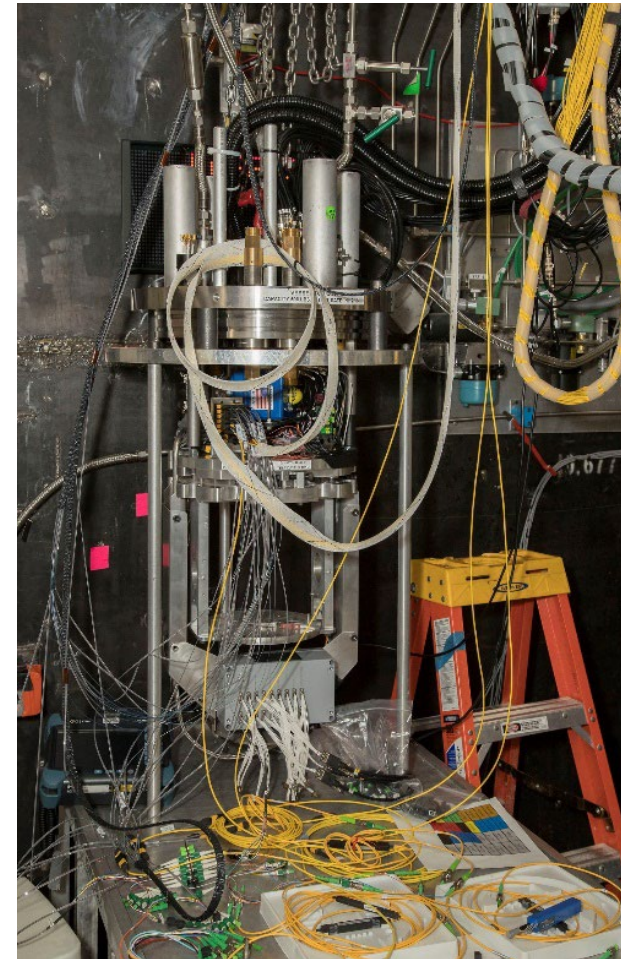


LANL Mk. 10 generator test at TA-39-88

T+: +0.001 ms
Rate: 170000 Exp: 0 μ s

What are Subcritical Experiments?

- Subcritical Experiments (SCEs) are
 - Subsets of Integrated Weapon and Focused Experiments that contain SNM (Pu)
 - Tests are designed to emulate primary implosion
 - SCE testing does not create a nuclear detonation
 - Dynamic experiments are conducted both above and below ground



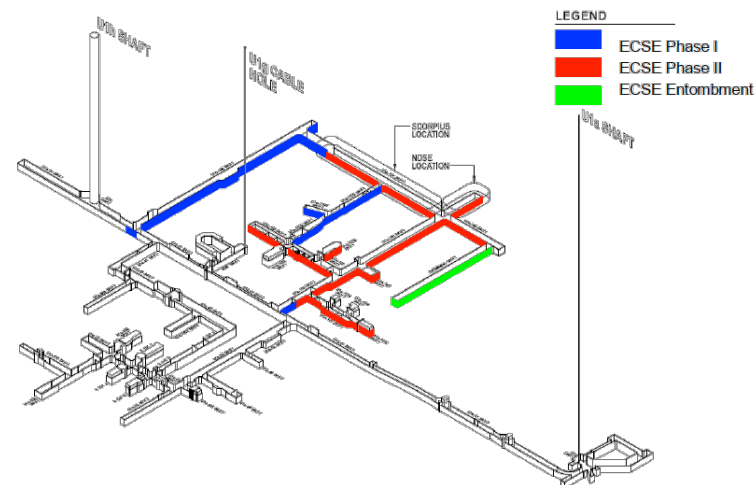
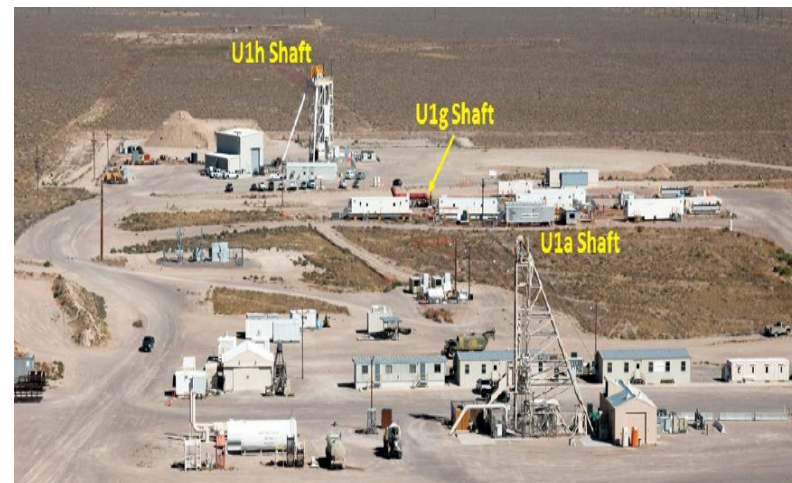
Why Do Subcritical Experiments?

- SCEs are performed to study nuclear material performance
- These tests allow NW designers to understand the **integrated** dynamic plutonium response of a weapon



Subcritical Experiments in Nevada, at U1a, Using Plutonium

- Since the end of full scale NW underground testing, we have conducted subcritical integrated plutonium hydro-tests in Nevada at the National Nuclear Security Site (NNSS)
- SCEs complement smaller-scale and focused plutonium experiments conducted at Los Alamos
- Testing support needed to conduct an SCE includes Fielding Schedule Management, Test Bed Configuration, Source Diagnostics, Timing and Firing Criticality, and Evaluations with Peer Review
- Los Alamos leads the national NW testing collaboration with Livermore, Sandia, and Nevada
 - A new underground facility is planned for NNSS at U1a
 - Enhanced Capabilities for Subcritical Experiments (ECSE) are to be operational by 2025 and will include:
 - Scorpius (DARHT-like X radiography)
 - A new diagnostic, Neutron-diagnosed subcritical experiments (NDSE)



What are Environmental & Engineering Tests?

- Performed to Understand and Qualify the function of non-nuclear materials and components
 - Usually performed during a Life Extension Program (LEP) or Alteration (Alt) of a Weapon in the Stockpile
 - Tests include ground and flight environments, accelerated thermal & mechanical lifetime tests, shock & vibration tests, etc.



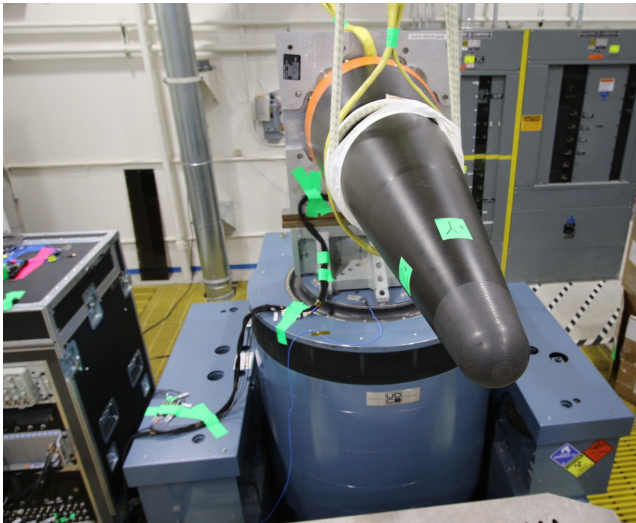
F-35A in flight - B61-12 Test



W88 Alt 370 Centrifuge
Reentry Testing

Why Do Environmental & Engineering Tests?

- Environmental and Engineering tests are performed to qualify components and subsystems and ensure Life Extension Program or Alteration changes made to a weapon will meet or exceed the weapons performance, reliability, and safety requirements



W88 Alt 370 Vibration Testing



Thermal Test Facility TA-16 (S-Site)

Environmental & Engineering Tests – W88 Alt 370 Hostile Blast Testing



- High-fidelity, high-explosive test body with mature Alt 370 hardware undergoing simulation of impulsive loading from hostile blast encounter



W88 Alt 370 undergoing blast testing at TA-36 Lower Slobbovia firing site

What are Hydro-tests?

- A Hydro-test is a mockup of the events that trigger a nuclear detonation
- Hydro = an integrated dynamic experiment with a weapon or weapon-like geometry being tested
- Hydro-tests include:
 - Full-up mockups of weapons using a non-fissile surrogate
 - Radiographic (X-Ray) focused tests
 - Optical & JOPIN (JOint radiograph and PIN) focused tests
 - Combination tests

Why Do Hydro-tests?

- Hydro-tests give NW designers the knowledge needed to certify our weapons without NW underground testing
- Hydro-tests provide X-Rays of the inner workings of a NW while it is undergoing implosion
 - At DARHT 4 or 5 X-Ray snapshots can be sequenced while implosion is in progress in order to characterize the symmetry of the implosion



Containment/Confinement used with Hydro-tests

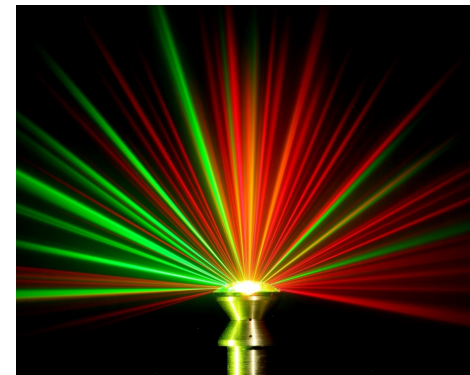
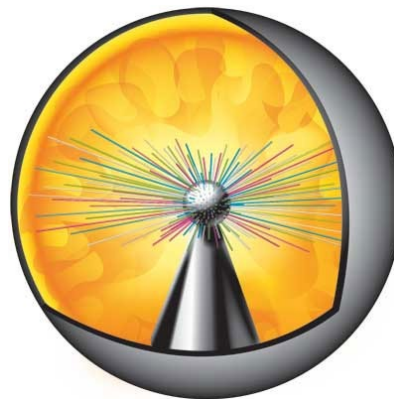
Containment & Confinement provide important Testing Controls

- Typically spherical or cylindrical with hemispherical heads
- Can contain up to several hundred kilograms of high explosives
- Can be used to contain plutonium and other hazardous materials
- Can be single- or multi-use
- Reduce Fire danger
- Protect the Environment
- Personnel protection



Diagnostic Footprint for a Hydro-test – Hydrodynamic Testing Technologies

- Fast framing cameras
- Flash x-ray generators
- Foaming and material control
- Gas guns
- Laser velocimetry
- Miscellaneous high bandwidth equipment (cables, connectors, pulse generators, etc.)
- Pin/PDV/optical domes
- Pressure transducers
- Pulsed power & pulse generators
- Streak cameras
- Transient recording devices
- Vessels & firing chambers
- X-ray recording systems



DRS Imacon 200

Framing rates are programmable from 1000 to 200 million fps.

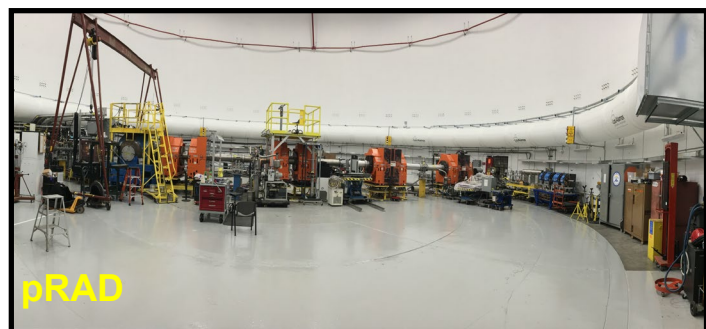
Firing Sites Support Various Testing

Specialized facilities to conduct experiments with HE or other energetic materials

- Robust construction
 - Bunker & Camera Room
 - Firing Point or Mound
- Open air, confined, or contained detonations
- Often use vessels & chambers with “windows” & “feedthroughs”
- Small & large caliber research guns
- Broad spectrum of diagnostics



Firing Sites at LANL and NNSS



Hydro Shot at Lower Slobbovia – IR Movie Camera Footage



Hydro Shot Fired in a Hesco House at R306



Conclusions

- Ongoing NW Testing is essential for maintaining our National Deterrence Posture
- Some Manhattan Project technologies still exist today in our modernized experiments
- Most testing today has a sizeable cost, facility and equipment footprint
- Modern technology offers sophisticated diagnostics that readily adapt to NW testing
- Increasingly, testing is being conducted indoors, using elaborate containment/confinement methods, providing the most protection to the environment and personnel, while still meeting SSP guidance and ensuring that the U.S. NWs remain fully viable
- NW testing has and will continue to evolve, as nuclear weapons have, over the last 75 years

Thank you!

Questions?



Email us: NFO@lanl.gov